The Northwestern MILLER
MILLING PRODUCTION SECTION

Recent Developments in Methods for Detecting Internally Infested Wheat

By Max Milner
Department of Milling Industry
Kansas Agricultural Experiment Station

THE determination of the milling industry to bring about a reduction in the number of insect fragments in flour has resulted in notable progress over the past few years in the development of techniques which permit the manufacture of cereal products under high standards of sanitation. Some of the methods devised for this purpose are so recent that probably not all mills are making use of them.

It is now generally agreed that the presence of insect fragments in mill products is due primarily to infestation in the wheat received by the mill. This conclusion is inevitable in view of the excellent plant sanitation standards now being maintained throughout the industry. In recognition of a probable relationship between internal infestation in wheat and the fragment content of milled products, the Food and Drug Administration is conducting a comprehensive survey on this problem in a representative group of mills. The results of this work, when completed, should establish these relationships clearly.

Operative millers have made remarkable progress in the difficult problem of producing acceptable flour from market grain which too frequently contains excessive amounts of internal infestation. Prebreaking of wheat by impact and other means, followed by special aspiration techniques, etc., have come into widespread use for removing or minimizing the effects of internally infested kernels responsible for the insect fragments in mill streams.

At the present time the miller is forced to buy grain which may contain internally infested kernels, simply because no adequate grading standards exist for the identification and segregation of such grain and also for the reason that there is no realistic scale of grading penalties which might tend to discourage the marketing of such grain. It is conceivable also that circumstances may arise where a miller may find grain of ideal sanitary characteristics unavailable, particularly when he is seeking a specific lot of wheat of special quality characteristics.

Grain Standards "Unrealistic"

The present interpretation of the U.S. Grain Standards is highly unrealistic because it specifies that wheat may be degraded due to infestation only when live insects are visible on the grain or when actual physical damage is apparent.

Unfortunately, however, the major obstacle to the introduction of grading standards for internal infestation is the simple fact that no quick and reliable test exists for the detection of internally infested kernels which could be used by personnel responsible for the grading and purchase of grain at the source or at terminal markets. Realization of this problem has prompted considerable investigation of methods for detecting internally infested wheat. Frankenfeld (3) in 1948 announced a stain test to make visible on grain the gelatinous insect egg plug of granary weevil and rice weevil. This plug is secreted by the female following oviposition, to cover the hole bored into the grain. The test consists of treating the suspected sample with a solution of a red dye known as acid fuchsin, followed by rinsing. The egg plug takes up the dye and thus becomes visible. This test has been adopted by many laboratories and is used as a presumptive test for internal infestation of grain. Iodine solutions have been used in a similar manner (3).

Acid Fuchsin Stain Inconclusive

The acid fuchsin stain test has been of very great value but it does not appear to provide all the information required by the miller regarding a sample of internally infested grain. It yields no knowledge of the stage of insect development within the kernel, which must be known in order to predict accurately the probable fragment count in the flour; in fact, it does not even indicate whether the insect egg has hatched.

A drawback to the test is that any exposure of the endosperm, whether due to insect feeding activity or to mechanical damage, will also take up the dye and may therefore be mistaken for the true egg plug; this may cause an overestimation of plugged kernels, particularly by inexperienced personnel. These limitations have restricted the possibility of using the test in grain grading and inspection, although its simplicity has made it useful for preliminary grain evaluation. Another color stain test has been suggested (4), which is probably subject to the same limitations which apply to the acid fuchsin and the iodine stains.

Another technique suggested recently (2) involves rendering wheat translucent in order to detect the insects inside the kernels visually. This

(Continued on page 6a)

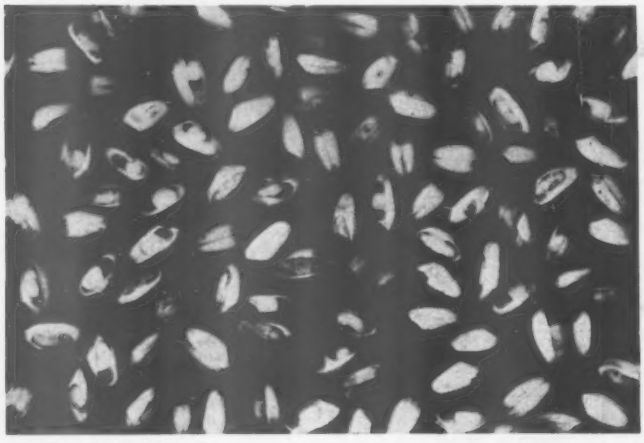

Fig. 2—Internally infested wheat as it appears in an x-ray photograph, showing rice weevil at various stages of development prior to emergence of mature insects.

Fig. 3—This picture is of the same sample of wheat shown in Fig. 2 as it appears under ordinary light. The picture was taken 18 days later when insect emergence was complete.

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Milling's Golden Era

Development of the Reel

By W. D. Gray

EDITOR'S NOTE: The accompanying article is the 14th in a series being published under the heading, "The Golden Era of Milling." This and the preceding articles in the series were published originally in The Northwestern Miller more than 50 years ago and were written by W. D. Gray, a leading flour mill engineer at that time. Mr. Gray, in the articles, reviews the many developments in milling technology that came about in the period 1875-1900, including the steel roller mill, middlings purifier, dust collection equipment, etc. In this article he reviews the development of the reel.

MANY things are often permitted to remain because they are already with us, and have been for many ages. An attorney gets a case, and after studying it over, begins to look for precedents, on the ground that if he can find similar cases decided in his favor, then his side of the question is right. When the case is tried, the judge looks over his law books to find similar ones, and if he renders judgment in accordance with the majority of his predecessors, then he thinks he has done both justice and his duty. So, also, we find men who say that "this was good enough for my father and grandfather, so it is good enough for me."

Especially in the old European countries do we find the son of his father; and whether he be a poor cotter or a rich merchant, he followed in the footsteps of his father and forefathers, doing the same business and in the same way, not daring to step to one side, or change, for fear of making a mistake.

This may be a safe way, but it cannot be said to be a progressive one. I believe it to be better to step out of the well-worn rut and try the experiment of doing better, at the risk of making a mistake, or even a total failure; for he who never makes mistakes never does much of anything.

So it is with nations. Spanish rule seemed to have answered for the government of Cuba, Puerto Rico, and the Philippine Islands, but the time came when the inhabitants of these islands wanted to follow in the paths of more enlightened nations and throw off the yoke of oppression; so that it was good to have a Gomez and a Garcia to try the experiment of improving their condition even should they fail.

So it is good with individuals and corporations to have some one come forward occasionally and say that this system of things has continued long enough and we will have a

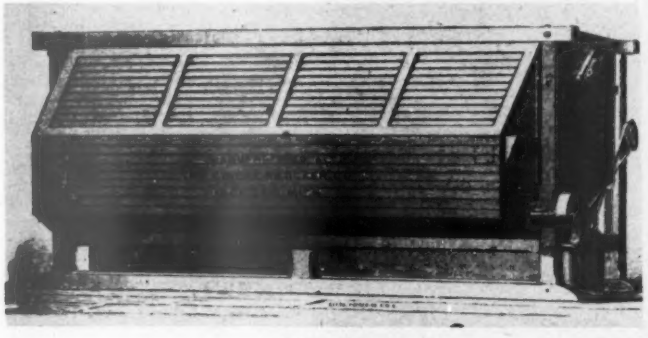


Figure 1

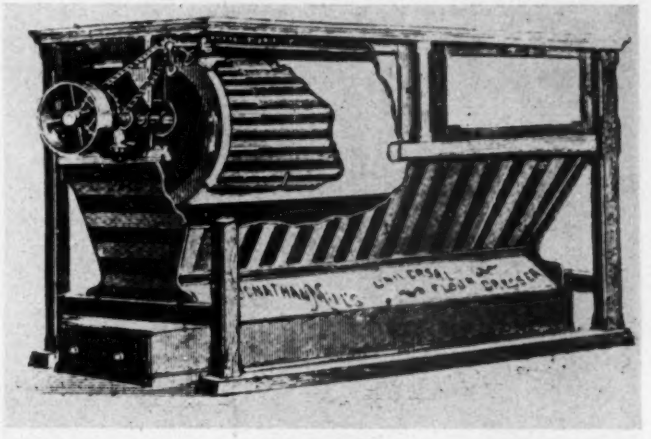
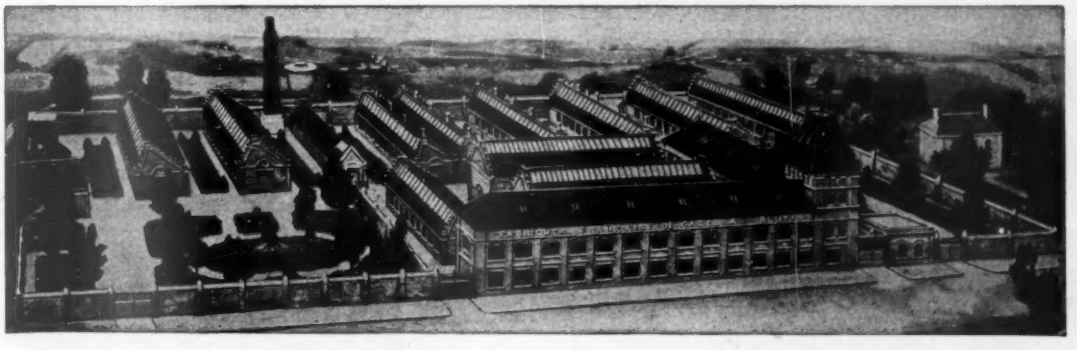


Figure 2



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change, even at the expense of being considered a crank, a revolutionist or even a rebel, if by so doing conditions are changed for the better.

Of course there are many changes that are not improvements; but we never get improvements without trying experiments and making changes, and if by many trials we succeed in getting one permanent improvement, then our time has not been spent in vain. In the art of milling, the old French buhr stayed with us for generations, none daring to question its right of possession.

Father and son, one generation after another, had gone on and ground grist, apparently never giving the matter a thought as to whether another tool could be found to do this part of milling better than the stones. They seemed satisfied with securing a good grade of French buhr and keeping it in face and balance; and so kept on making flour for the millions and it answered because there was nothing better. No one questioned the quality of its work until the rolls came and forced themselves upon the trade.

They were accepted by many with misgivings because of the good character and long standing of the millstone. But in all industries there are a few who are progressive more than their contemporaries. These few were found among the millers and they were persuaded to adopt the new machines as an experiment. The few were not slow to recognize the good qualities and their great advantage over millstones. Then, after the progressive millers had adopted them and produced better results, the conservatives had to adopt them, by way of self-protection. No one doubts but this was a permanent and substantial improvement.

If the American millers were now from any cause compelled to give up the use of rolls and go back to millstones, they might supply some domestic trade, but I am inclined to think that it would be largely confined to a set of cranks who want flour with what they call a "nutty flavor," or to a set of doctors and their patients who think they must have whole wheat flour, or, in other words, a certain amount of indigestible impurities mixed with the flour. Possibly this class of individuals might keep a few millstones going, but the foreign countries that use the rolls would buy our wheat and sell us back the flour. If this be true, then there can be no doubt of the tremendous importance of rolls in the milling business.

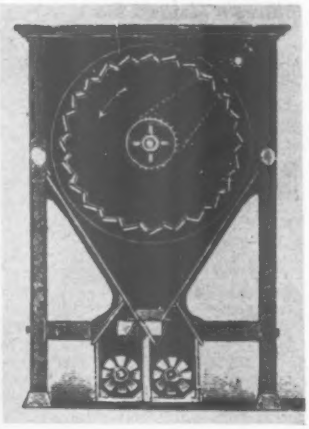


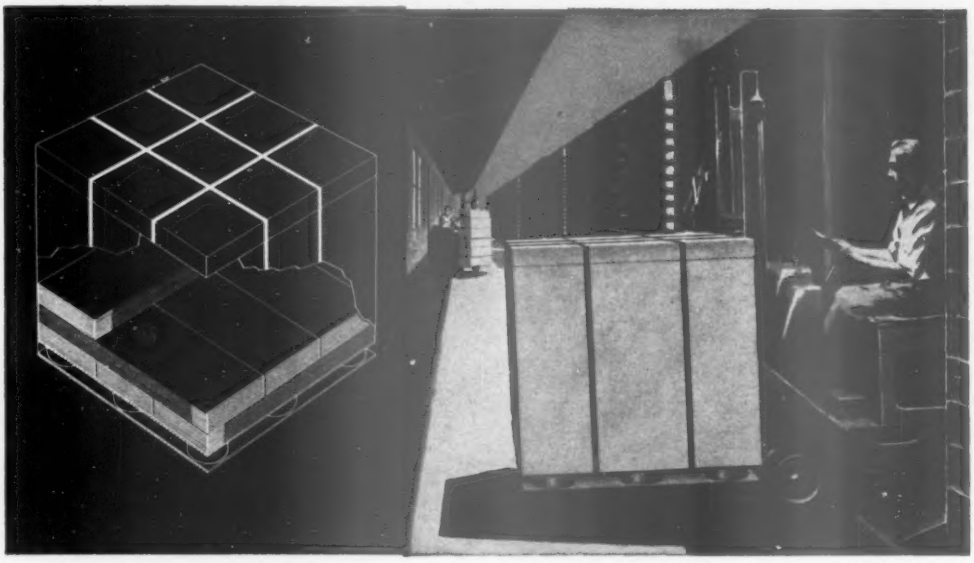
Figure 3

Shortly after the rolls had displaced the millstones, millers, milling engineers and investors turned their attention to the old hexagonal reel. While this machine could not boast of so long a record, its history was just as well founded and honorable.

It would seem a waste of time to describe this reel, as everyone knowing anything about milling knows its construction. It is enough to say that it was usually from 32 to 40 in. in diameter and from 18 to 22 feet long, with two conveyors running the whole length. While this reel had done good service for years, and to many it seemed like sacrilege to disturb it in its good work, the trade had got started and was looking for improvements, and anything that looked reasonable would be tried by the progressive miller.

In the meantime, we had imported from Europe a machine built on the bran-duster order, viz., a centrifugal. This machine had an outside cylinder covered with silk, running slow or at about the speed of the ordinary reel, while inside the cylinder was placed a fast running, or beater-shaft, with spiders and beaters, the beaters clearing the cloth about one foot, making it a force bolter. The first of these machines was rather crude but being used on such stock as they seemed adapted to, usually low-grade stock, they did a remarkable lot of work and did it well. But it soon became evident that while they could not do all the bolting in a mill, they had a place, and that place seemed to be towards the tail-end of the mill. That is where they remain at this day.

It was not long before this centrifugal was improved and manufactured by the principal mill-furnishers, including the Smith company. These machines were usually of about 32 in. in diameter by about 8 ft. long; and, as their place in the mill was limited, there was at once a great desire to get machines or reels of about the



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same size as the centrifugal that would do as much work as the long, cumbersome hexagonal reel.

After thinking of all the good things that could be said about this reel, the fact still remained that it took up a great deal of room in a mill, took a great deal of power to drive it, the action of the stock in the reels was not based on very scientific principles, and after the reel got through with it there were still the two long conveyors to mix up and pulverize the stock. These things were bound to tell against it in the long run.

The Smith Purifier Co. was still controlling the manufacture of the purifiers, and was then trying to control the manufacture of centrifugals. This they might have known that they could not do, as Edward P. Allis Co. was manufacturing them before they were, and did not propose to stop through any threat of theirs.

Among the first bolting devices that were tried to take the place of the old hexagonal reel was the Morse bolt. See Fig. 1. This machine was distinctly different from the reel, and as it seemed to do good work it captivated a good many millers and there were many of them in use.

This machine had a sieve with a jarring motion and a traveling brush under the cloth to keep it clean. The sieve was the full length of the machine, 6 or 8 ft. by 20 to 30 in. wide, lying at an angle of about 60°. Under this sieve were two conveyors the same as under a reel. There was an elevator with buckets the whole length of the sieve. Stock was fed to the buckets at the head. The elevator carried it up and discharged it on a distributing board with fingers that could be adjusted to make the stock travel toward the tail of the sieve. What did not pass through the silk passed down to the foot of the elevator and was carried up and discharged on the sieve a little nearer the tail, until the tailings passed off the tail of the sieve, the same as in a reel. What bolted through this incline sieve showed very nice work and the machine might have lived longer had it not been for its mechanical construction. It was so constructed that it took a good mechanic to run it. One of its tricks was for one end of the belt to gain on the other, and, the cups getting crosswise on the upper pulley, it would go to pieces. This, of course, could with care be avoided; but the machine could not be counted on, and so passed into history.

About the same time that the Morse bolt was being experimented with, experiments were being made on short, round reels. Up to this time the most successful reel of this type was made by a man well versed in mechanics but who was rather too much given to experiments. He no sooner got what he thought was a good thing than he would drop it and try to get something better, instead of pushing what he had and getting some money out of it. It usually happened that he let go after the other fellow had got something as good or better than he had. In other words, he was a mechanic and inventor, and not a good businessman. This man was Jonathan Mills, for a long time well known in the milling trade, and, I am inclined to think, deserved more for his efforts than he ever received; possibly this was largely his own fault. See Figs. 2 and 3.

His reel was, in its time, without doubt the best. It was constructed with a solid wooden cylinder, with flutes or corrugations on the periphery, with an iron hoop surrounding the cylinder and leaving a space of from one to one and one half inches between the silk and the corrugations. These hoops were supported by little strands from the cylinder. One of these hoops was placed every 10 to 12 in. the whole length of the reel, to support the silk, with the usual arrangement to fasten the silk at either end. The stock was fed in at the head of the reel and caught in the corrugations, and the reel, running about 30 revolutions a minute, carried the stock up and spread it on the cloth. The intention was to bolt most on the up-going side. This machine was built in the usual style, about 8 ft. long, with two conveyors.

It was very popular for a while, and a great many of them were sold and used. It had merit enough to set all other reel-builders to thinking and experimenting, to get something as good or better. Everything in the way of solid, smooth or corrugated cylinders was tried, and to a great extent found wanting.

The Holt or Smith Inter-Elevator bolt, which was to some extent copied from the Jonathan Mills reel was made in various forms, but was not considered as good as the latter.

The trouble with all reels of this type was that these corrugations, no matter what shape or whether they consisted of a straight rib put on a smooth cylinder, would load up. Very often the space between the cylinder and the silk fills up, the stock revolves with the reel, and, of course, ceases to bolt; and, should it not go to this extreme, the stock will

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lie in the recesses. While there, of course, it is not in contact with the silk, and the result is small capacity; the reel always carrying a very heavy load, it is hard on the silk and takes too much power. All the reels of this type, with solid cylinders, having corrugations or flutes, have this same trouble, and, of course, these reels were good only until a better was presented. However, this seemed to be a step in the right direction.

Detection of Internal Infestation

(Continued from page 1a)

is accomplished by boiling the grain in a 10% solution of caustic soda followed by thorough washing. As yet there has been insufficient general experience with this method to indicate its potentialities.

The "Cracking-Flotation" Test

In answer to the need for a test which not only would yield information as to the presence of insects in a grain sample but which also would provide conclusive evidence as to their numbers and stages of development, several milling sanitation specialists have developed an excellent method now generally referred to as a cracking-flotation test (1). In this procedure a sample of the suspected grain (200 to 1,000 g.) is coarsely ground in a buhr mill, just sufficient to release the insects existing in the grain, without macerating them unduly. The mixture of meal and insects then is suspended in water, the suspension clarified either by boiling with acid or by treatment with a starch-splitting enzyme, and the insects and insect parts separated by flotation methods using liquids such

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The insect parts then are filtered off and are identified and counted with the aid of a microscope. The method is subject to errors of sampling but it does yield direct and pertinent information regarding the status of the internal infestation of wheat. Its manipulation requires considerable skill and experience in order that reliable and replicable results may be obtained; also the test is time-consuming and costly, and therefore has not been used for the grading and inspection of grain before purchase. It is extensively used for the segregation of infested grain which already has been bought by the miller, for binning and for the control of mill mixes. Accordingly, it allows the miller a large measure of control over the fragment count in his products even though it does not permit him to buy his wheat with previous knowledge of the extent of the internal infestation which it contains. Much credit is due to the sanitation specialists who have brought this test to its present high level of utility, since it is virtually the only reliable means currently used by the industry to control the internal infestation of wheat going to the mill.

The more progressive milling laboratories appear to be using the acid fuchsin stain test as well as a cracking-flotation test for the supervision of their wheat mixes. In addition, several laboratories section a number of the suspected kernels in order to determine the probable impairment of milling yield due to internal depletion caused by feeding damage.

"Perfect" Test Not Available

A test for internal infestation in wheat which answers all the pertinent questions which the miller might ask is not yet available to the industry. An ideal method would possess the simplicity and speed of the stain test but also would provide at least the specificity of information on internal infestation yielded by the cracking-flotation techniques. In addition, it would provide considerably more reliable information on the extent of internal impairment of the grain than is possible by techniques now in use. The ideal test should indicate whether the infestation is alive or dead. Probably no single test will ever be developed which can supply the answers to all these questions simultaneously.

The justification for such a test is almost self-evident. Primarily, it is important to know the extent of internal infestation, and it is important furthermore to be aware of the distribution of the various developmental stages of the insect, since larvae, pupae and mature insects, even if present in equal numbers, would yield different amounts of identifiable fragments.

The extent of internal depletion of kernels due to larval feeding must be known in order to predict the loss in grain to be expected on passage through the cleaning equipment, as well as the decrease in milling yield due to the presence of such kernels in the mill mix.

Finally, information as to the viability of internal infestation is directly useful for intelligent fumigation practices. Fumigants are expensive, and at the time when this is written, are increasingly hard to procure. Information as to internal insect viability probably would permit a substantial economic saving in the fumigation program of any mill.

The major importance of a test for viability of internal infestation will be fully realized only when and if grading definitions for internal infestation are introduced into the U.S. Grain Standards. If this development occurs, then obviously quantitative limits for internal infestation in the various grades will need to be fixed. It follows that the practice of mixing grain to meet grade requirements for internal infestation may become as prevalent as it now is for meeting other quality considerations.

Under such conditions the mixing of small amounts of infested grain with larger lots of insect-free grain

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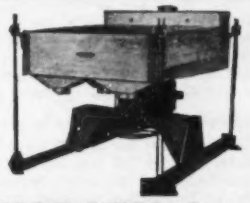

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(1) Personal communications from Howard Stedman, Rodney Milling Co., Kansas City, Mo.; George Wagner, Pillsbury Mills, Inc., Minneapolis, Minn., and Eric Kitely, International Milling Co., Minneapolis, Minn.

at a country shipping point for the purpose of up-grading is to be expected; and even if the infestation in such grain is alive, such lots might well pass through inspection points and into a purchaser's bins before evidence of the serious consequences of this practice becomes apparent.

Infestation Detection at Source

Unless a test for live internal infestation is carried out at the time of purchase, and corrective measures such as fumigation applied if necessary, very serious deterioration in quality would appear only after several weeks of storage in the purchaser's bins, due to emergence of insects from the infested kernels and their attack on the uninfested grain.

The University of Wichita Foundation for Industrial Research recently announced a simple sectioning method for determining internal infestation (1, 8), which involves cementing a layer of grain to the surface of a metal plate and sanding or grinding off a portion of the sample in order to reveal any internal insects or their feeding cavities.

Ultraviolet light is used to facilitate the detection of insects since it causes the excreta within the feeding cavities to fluoresce. This method should prove very useful for the detection of internal infestation in advanced stages where the feeding cavities are so large that they invariably will be revealed by grinding off only a portion of the grain, and should also be useful for predicting losses in milling yield due to infestation. Whether the test can be used to detect early stages of internal infestation or whether it can yield evidence of the viability of the insects, remains to be seen.

In the Department of milling industry at Kansas State College a research project dealing with internal infestation and the fragment problem has been under way in the past several months. The major objective of this study is to explore the relationship between internal infestation in wheat and the extent of fragment formation in mill products, including an investigation of the utility of various modern grain-cleaning machines for removing internally-infested kernels from grain. The practical objective of these studies is of course to indicate means for reducing the fragment count in mill products.

Upon initiation of these studies it became immediately apparent that research work in this field would be seriously handicapped until better methods were found to determine internal infestation in all stages in wheat. This need for methods was was considered so pressing that considerable time was devoted to such studies.

Berberine Sulfate Stain Test

The first investigations dealt with the development of improved methods for detecting the insect egg plug. It was felt that this very useful test for internal infestation could be made more specific without sacrificing the simplicity and ease of manipulation of the color stain tests already in use. This proved to be the case.

Following a systematic study of a large number of color stains and fluorescent dyes, it has been found that after immersion of a sample of wheat suspected to contain internal infestation due to granary or rice weevil into a very dilute solution of berberine sulfate (20 p.p.m.) for one minute, selective staining of the gelatinous egg plugs occurs; this becomes evident when the sample is held in the rays of an ultraviolet lamp having major emission at a wavelength of 3,660 Angstrom units. The intense yellow fluorescence of the egg plug can be detected easily without auxiliary lenses. No staining of the endosperm, bran, insect parts or excreta occurs, nor is any washing or rinsing of the grain necessary if the staining time is held to one minute. The specificity of the stain for the egg plug is evident in Figure 1, which is a picture taken under ultraviolet light

Fig. 1—The above picture is of infested wheat that has been treated with a solution of berberine sulfate. The egg plugs are plainly visible under ultraviolet light and appear to the eye as bright yellow spots.

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of a sample of grain badly infested with granary weevil and treated with The egg plugs appear as white spots berberine sulfate solution. The egg plugs appear as white spots in the picture and it is to be noticed that the numerous insect feeding injuries and cavities are unaffected by the test. A preliminary report of the method has been published (6).

Considerable useful information concerning weevil-plugged wheat kernels has been obtained in this laboratory as a result of the development of this test. The fluorescent stain has been shown to be more specific than the color stains for the egg plug, and the tendency to overestimate plugged kernels, which is a characteristic of the color stain tests, is minimized.

Preliminary studies on the relationship of plugged kernels to total internal infestation as determined by a cracking-flotation procedure have encouraged the belief that a reliable staining test for weevil egg plugs may yet prove to be a more useful grading adjunct than is presently believed.

X-ray Technique Development

Another development in the work at Kansas State College has been the application of X-ray techniques to visualize and record internal infestation of grain samples. Previous attempts in other laboratories to apply X-ray to this problem appear to have failed because of insufficient acquaintance with the techniques of modern industrial radiography. The rather positive results which have been obtained in these studies at Kansas State College are due to the cooperation of the staff of the department of physics, and particularly to the help of Dr. Robert Katz who is thoroughly acquainted with the special techniques of industrial radiography. Two publications have been issued on this phase of the investigations (5, 7).

The possibilities of the X-ray technique are apparent on examination of the radiograph reproduced in Figure 2, of wheat containing live rice weevils at various stages of development including eggs (indicated by the presence of egg channels), larvae at all stages of development, pupa, and mature insects ready to emerge from the grain. It must be pointed out that X-ray photographs are notoriously difficult to enlarge and reproduce. The cut for Figure 2 provides accordingly only a crude indication of the clarity of delineation provided by the original negative or even of that which may be possible by fluoroscopic methods. It is to be stressed that no emergence of insects had occurred from this sample, and that close visual inspection of the kernels at this stage revealed absolutely no evidence of the true internal condition of the grain as indicated by the radiograph. Figure 3 is an ordinary photograph of the grain sample taken 18 days after the radiograph in Figure 2, when insect emergence was well under way. Individual kernels in Figures 2 and 3 are in the same relative position, and accordingly the internal condition of kernel just prior to insect emergence may be compared directly with the external appearance of the same kernels 18 days later.

Different Stages Identifiable

In Figure 2 larvae occur as white spheroidal areas enclosed in the dark void of the feeding cavity. The indistinct margins of some of the larvae are due to movement of the insect during the period of photographic exposure. Egg channels and other anomalies due to insect activity are readily apparent. Pupae are easily identifiable by their more articulate margins, and mature insects by their clearly visible skeletal differentiation. While the insects which appear in this radiograph were living, it has been found that dead larvae may be distinguished readily by their shriveled, distorted shape and rough outline, which is in contrast to the smooth-margined spheroidal appearance of living larvae.

The radiograph in Figure 2 suggests that this technique may be useful for estimating milling yield of a damaged sample, since it reveals clearly the normally invisible depletion of kernels due to internal insect feeding.

Radiographs also have been made of internally infested corn. It appears that the technique will be applicable to the detection of internal infestation in any seed or natural material which is subject to insect attack. Commercial X-ray equipment readily adaptable for such determinations appears to be available at a cost which should be within the reach of most milling and grain testing laboratories.

The various newly-developed techniques which have been described promise to be of assistance in dealing

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with the problem of internal infestation. It is not clear at this time whether any of these methods can be utilized at the country shipping point where purchase and grading of grain occur initially. This will be known only as general experience and confidence in the methods are developed.

At the mill and terminal market level, it seems probable that the X-ray test can provide the information necessary to identify and grade grain rapidly on the basis of internal infestation. This technique appears to offer possibilities as a grading adjunct for wheat marketing as useful at least as the protein test, since the data it supplies may be made available in a matter of minutes, and probably at a similar cost.

The problem of internal infestation is of such grave importance to the milling industry that the encouragement of continued research into the problem seems highly desirable. With the availability of the X-ray method as an absolute test for internal infestation, an impetus is provided to continued research, the objective of which would be the development of even simpler and cheaper methods of detection having widespread utility and acceptance. It is also to be hoped that further research activities will be concerned with the possibility of developing mechanisms for sensing internally-infested kernels in such a rapid manner that an apparatus may be designed for eliminating such kernels from a stream of grain.

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Formula Feed Production School

EDITOR'S NOTE: Following are summaries of selected lectures presented at the first annual Feed Production School sponsored by the Midwest Feed Manufacturers Assn., at Kansas City, Nov. 27-29, and attended by more than 250 formula feed mill superintendents and allied representatives. The lectures consisted mainly of discussions of production problems in formula feed plants.

Dimensions, Number of Grinding Bins

Karl F. Nedela, production manager for Crete Mills, Crete, Neb., gave the mill superintendents several valuable suggestions about mixing and grinding bins in formula feed mills.

Mr. Nedela said that grinding bins should be large enough to hold one day's grind and that the number of bins in a plant is dependent upon the number of ingredients used in compounding formula feeds.

He said that some formulas may need two bins for the same ingredient and cited scratch feeds which contained about 50% corn as one of these feeds.

For bulk storage bins, Mr. Nedela said that a minimum size should be of one carload capacity. He recom-

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mended that material which is received in sacks should be dumped and put into the storage bins upon receipt. His reason for this was that it was more economical to handle bulk ingredients than it is to store them in the warehouse and rehandle them.

Bins can be too large in dimension, he said. For rectangular bins, he recommended either 5 ft. by 8 ft. in dimension or 6 ft. by 6 ft. He said that the cross section area of a bulk storage bin, if it is of substantial depth, should not exceed 40 ft. He said a bin 8 ft. by 8 ft. in cross section is too large, especially for soft materials like millfeeds since bins of that size bridge frequently.

Mr. Nedela said that bin walls should be as smooth as possible and that the hoppers should have at least two sides straight and the slanting sides should have angles of at least 70° to insure even feeding into the feeder from the bin.

As for total bin capacity in a plant, Mr. Nedela recommended that this capacity should not exceed one week's production of the mill.

Mr. Nedela was also invited to discuss the different types of grinding machines used in formula feed plants. He said that attrition mills are "not too satisfactory," because, he said, they require too much power and maintenance. He also discussed briefly the subject of the use of roller mills for producing scratch feeds and recommended Lepage cuts of four to five an inch on horizontal roll for hen scratch, 10 cuts an inch for chick scratches, that the fast roll should run about 500 r.p.m. and with a differential of about two to one.

Mr. Nedela advised the superintendents that if their managements were planning to build new feed mills that the nutritionist, the grain buyer and the superintendent should be members of a planning committee to assist with the construction company and engineering firms in planning the mill. The nutritionist can supply information regarding the number of bins needed for the different formula feed ingredients. The grain buyer, he said, can offer many useful suggestions about the sizes of the bins for the different ingredients and also about their location. The superintendent, Mr. Nedela said, should also be consulted regarding installation and placement of machinery "since he has to run the plant, he certainly should have some ideas about its construction."

Cutting Labor Costs in Mill Operation

Jean P. Best, general superintendent of the Burrus Feed Mills, Ft. Worth, Texas, gave the feed mill superintendents many suggestions on how to lower handling costs in feed mill operation. Mr. Best urged that as many of the incoming ingredients as possible be handled in bulk because of the lowered handling costs. He has compared an operation of power shovels with the pneumatic system for unloading grain and said that the pneumatic system, while it is from 20 to 40% higher in cost, has many advantages.

A car dump, he said, is advisable or justified only if the volume of grain to be unloaded is very large, from 50 to 75 cars a day. He said that an initial investment of upwards of $200,000 is required to install an automatic car dumping installation.

Mr. Best emphasized the necessity for removal of tramp iron from grain and other ingredients and said there should be one magnetic separator before each high speed grinding machine. He said that the electric type is less reliable than the permanent magnetic type.

He also discussed different types of conveyors and outlined their characteristics. Among them were screw conveyors, belt conveyors, and pneumatic conveying machines.

Blending and Mixing Methods Discussed

Philip C. Murray, superintendent of the Centerville, Iowa, feed plant of Pillsbury Mills, Inc., said in a discussion, "Blending and Mixing," that manufacturing methods have not kept pace with nutrition advancements in the formula feed industry.

He listed four essentials in the operation of a formula feed plant. He said first that a good mixing job—an accurate job over a broad weight unitage—is necessary. The second point he emphasized was the flexibility of operation of the plant. The third point was that the plant must be capable of volume production; and, fourth, low cost operation of the plant.

He compared vertical and horizontal type mixers for use in batch plants and said that the vertical mixer is acceptable for small plants, and in his discussion he seemed to favor the use of horizontal mixers with the

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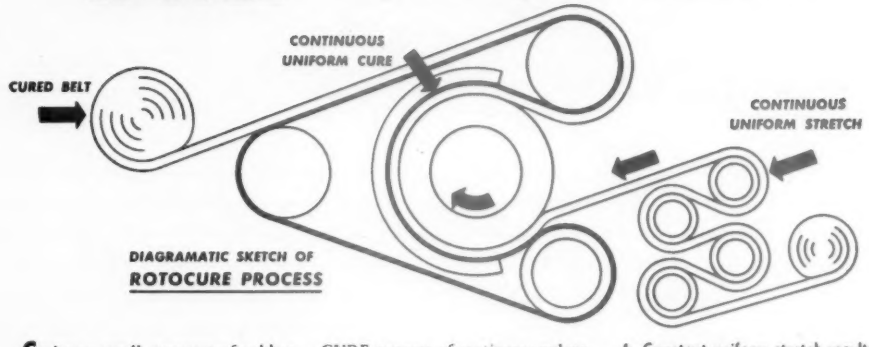

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ribbon type of agitator. He said that the horizontal mixers should not be operated at more than 60 r.p.m. and preferably between 40 and 60. He said this type mixer is good for use in medium-size plants.

"The heart of a batch mixing plant is the accuracy in weighing the ingredients," Mr. Murray said. A mixing sequence must be followed when producing formula feeds, and he recommended that the coarse ingredients should be put into the mixer first and that any trace minerals or other components of the formula which are small in total volume should be introduced in the mixer after about one half of the charge is in, and then the remainder of the bulk of the formula should be added.

He recommended the use of wing type feeders for the continuous system. He urged care in the setting of the feeders and cited some variations in the wing type feeders.

Gravitimetric types of feeders are becoming more popular, he said, in spite of the fact that they are quite costly. A gravitimetric feeder, he explained, is one that feeds by weight and the feeder can be adjusted to feed a uniform weight of material continuously. The density of the material does not affect the accuracy of its operation.

Mr. Murray emphasized strongly the need for installing labor saving devices wherever possible because of the "increasing labor costs."

Mr. Murray told the superintendents that the "double ribbon" type of high speed mixer was, in his opinion, not desirable for use on compounding formula feeds containing crimped grain. He said that the action of the double ribbon beaters "chews up" the crimped grain and as a result the finished feed does not look too attractive.

He also recommended the use of an attrition mill for blending molasses feeds. He said that it accomplishes an intimate dispersion of the molasses into the dry portion of the feed with good results.

He pointed out also that if a mill superintendent was thinking about bulk delivery of formula feeds, he would have also to think about installing adequate bulk storage tanks to hold the feed between the time of its manufacture and its delivery to the truck in order to save time.

♥ ♥

Production of Pellets, Crumbles

A discussion of pelleting, cubing and crumblizing formula feed was presented by M. M. Noxon, assistant general supervisor of feed plants for Nutrena Mills, Inc., a division of Cargill, Inc., Minneapolis. Mr. Noxon reviewed the introduction of pelletized feeds in this country in 1929 by his company. He said that the first pellets were made on machines imported from Great Britain and that in 1932 or 1933 the California pelleting mill was introduced. Later there have been others, including those made by Sprout, Waldron & Co. and the Anglo-American Mill Sales Co.

Mr. Noxon said that in pelletizing chick or laying mashes it would be necessary to add dry steam at from 60 to 90 lb. pressure to the feed in order that it would pelletize satisfactorily. He said that some formulas containing soybean oil meal might require some water plus steam. In a formula containing molasses, Mr. Noxon said that little or no steam is required in order to get the mash to pelletize properly.

He said that pellets "cost too much to produce if they are made from a formula containing a high percentage of molasses." He said that compounding the basic formula is the most important single factor in pelletizing mashes.

Mr. Noxon said that a pelleting machine was an expensive piece of equipment and that a qualified millwright or other worker should be charged with the responsibility of its proper maintenance. He cautioned against operating the machine at too high a speed and said that the machine should be well protected with magnets to guard against tramp iron since a piece of iron can ruin an

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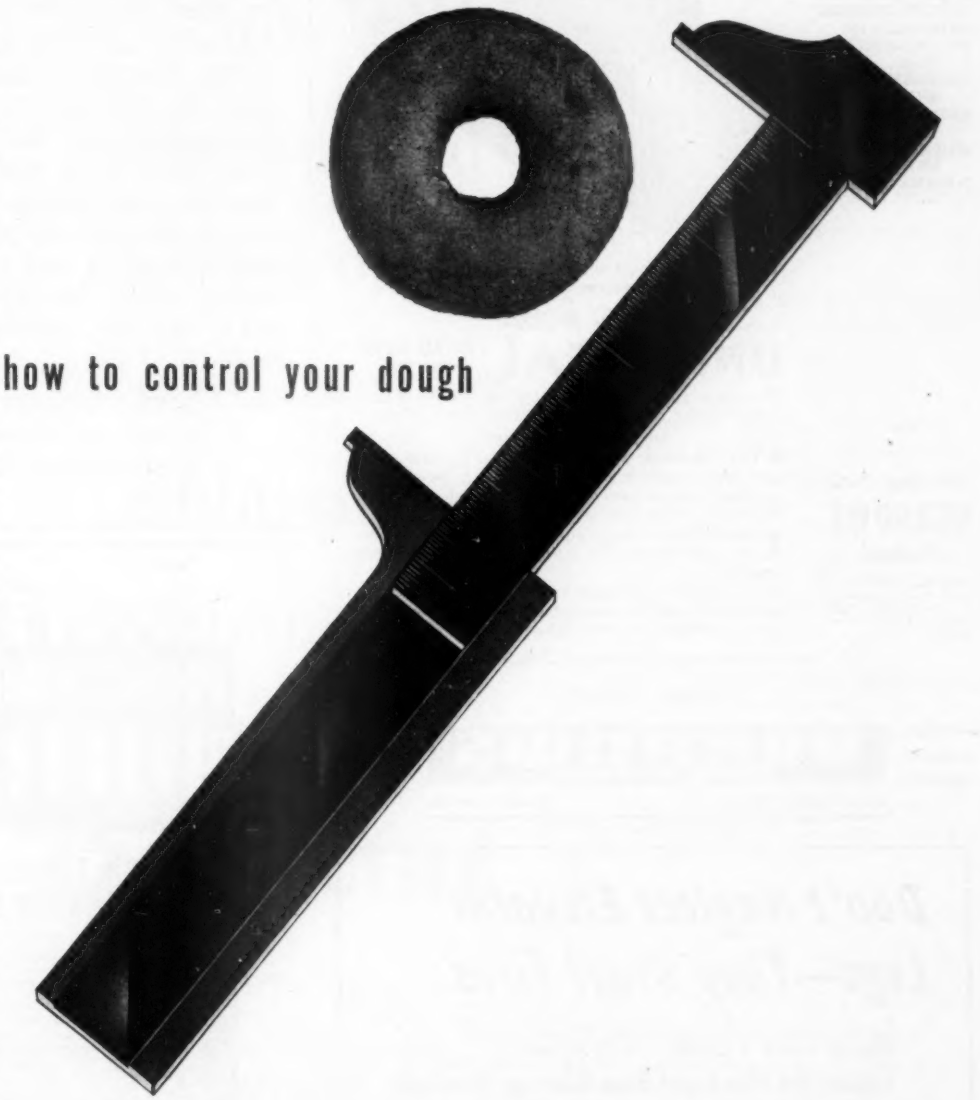

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expensive die.

Mr. Noxon, in discussing production of crumbilized feeds, said that roller mills produce the least amount of fines to be fed back into the pelleting machine.

Bulk Handling of Finished Feeds

The possibility of handling finished feeds in bulk was discussed by Paul Talmey, director of research and development for the General American Transportation Corp. of Chicago. Mr. Talmey's company recently has made a fleet of cars for bulk shipment of flour for the National Biscuit Co. and also has made cars for bulk shipment of fine chemicals, cement and other powdered or granular products. He said that more than 60% of the cement manufactured in this country is shipped in bulk by the use of covered hopper cars. He said that all problems connected with shipment of flour in bulk have been solved and said that since many of the formula feeds, particularly the mashes and concentrates, have about the same characteristics as flour, he does not see any reason why formula feeds could not be successfully handled in bulk shipments.

He estimated that a net saving of $3.37 a ton, or 16.8¢ 100-lb. sack of feed could be made by shipping feed in bulk. He said also that the "increasingly higher costs" of textile bags for packing feed was going to cause more feed to be handled in bulk. Mr. Talmey also discussed the use of "Tote" bins for the handling of finished feeds and formula feed ingredients in bulk.

Tote bins are closed metal bins with a capacity of about 3,000 lb. of finished feed. He said that the feed plant could ship feed in bulk with the use of Tote bins to distribution points and there be either reloaded in bulk from the Tote bin or packed in 100-lb. bags.

"Sooner or later the Tote system will be accepted" as a way of handling bulk feed shipments, he said. Mr. Talmey's lecture was supplemented by projection slides showing bulk cars which his company has made for handling flour as well as pictures of the Tote bin and the unloading device which is an integral part of the Tote system of handling bulk ingredients.

Handling, Storing Liquid Ingredients

James E. Leker, night superintendent of the Staley Milling Co. plant at Kansas City, Mo., presented a lecture dealing with handling liquid ingredients which are used in formulating feeds. He said that in handling and mixing liquid ingredients three factors must be considered: 1. The viscosity of the liquid. 2. The abrasiveness of the liquid, or the solids carried by the liquid. 3. The corrosiveness of the liquid.

He said that in mixing liquids of different nature such as fish solubles and vitamin feeding oils, it might be necessary to use an emulsifying agent in order to obtain an intimate blending of the two liquids.

Mr. Leker recommended that the storage tanks for liquids be installed above ground where possible, pointing out that if the tanks developed any leaks it would be immediately visible. He also said that tanks above ground were cheaper to install than those which required digging of a sizable pit.

All feeder lines, he said, should be insulated and heating of the tank or the line should be done only if necessary. All pumps handling liquid ingredients should be protected with screens and should also be equipped with metering devices. He also recommended pressure valves and temperature controls on all installations handling liquid ingredients.

Good Housekeeping, Safety Programs

"Safety and Good Housekeeping" was the title of a lecture presented by C. M. Park, chief engineer for the Mill Mutual Fire Prevention Bureau, Chicago, Ill. Mr. Park, during his lecture, gave the mill superintendents many valuable suggestions regarding fire and accident prevention in their plants.

He said there are inherent hazards in all machines in a feed mill. Most of them, he said, were centered around bearings and driving mechanisms, adding that anti-friction bearings have progressively reduced the incidence from fires and explosions caused by bearing failures.

In a discussion of belts, gears, chains and couplings, Mr. Park said that V-belts must be properly engineered to be safe. He said that a flat belt if overloaded, usually slips and jumps a pulley. Chain and gear drives, he said, do not introduce any

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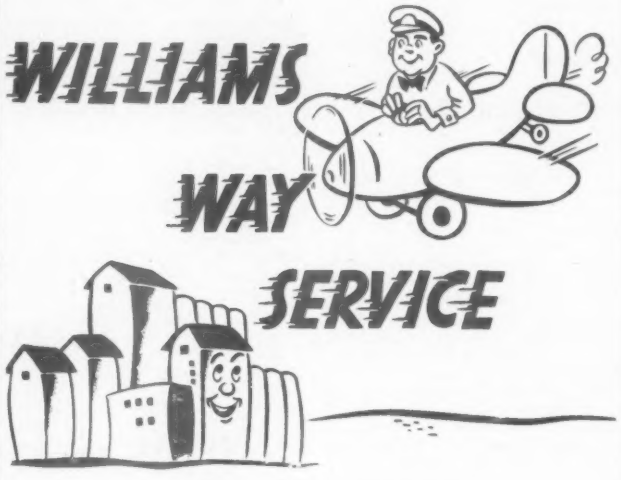

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particular hazards since they will usually completely stall the driving motor or brake. V-belts, however, cannot jump the pulley but remain in the groove, and, he said, a rubber V-belt is a very inflammable piece of equipment and will not stand too much frictional heat. He said that a V-belt drive should be capable of stalling the driving motor. He also recommended that drive installation be equipped with overload relays on the driving motor and also safety fuses.

On the subject of magnetic separators, Mr. Park said that magnetic separators should be installed before all grinding machines and wherever possible in the mill for added protection. He indicated that it was his opinion that there could not be "too many" magnetic separators in a grain processing plant because of the high incidence of tramp iron in the grain.

Elevator legs were described by Mr. Park as being the greatest single fire hazard in a flour or feed mill or grain elevator. To minimize the hazard of elevators, he recommended that each elevator have its individual drive with overload relays on the motors. He explained that a motor drive designed to drive three or four elevator legs would not stall if one of the elevators became choked up.

He recommended also the use of anti-friction bearings, particularly on the head bearing which bears the weight of the belt and the filled buckets. He said that there is a need for proper design for each elevator leg when individual drives are used.

In a discussion of electrical equipment, Mr. Park said that electric motors used in feed mills are subjected first to a dusty atmosphere and secondly to the abrasive action of the dust. He recommended that only motors bearing the approved national code from the underwriters laboratory should be purchased.

In mentioning lighting equipment, Mr. Park recommended the use of dust-tight equipment and where that is impossible that a vacuum lamp instead of a gas filled filament lamp be used.

Fork lift trucks used in warehouses, especially if they are gasoline engine powered, pose a fire hazard and explosion risk and he recommended that the use of such fork lift trucks be only upon the approval of the mill's fire insurance agent.

Mr. Park also discussed briefly the danger of spontaneous combustion in bagged and bulk materials in storage and cited particularly distillers and brewers grains and also soybeans and alfalfa meal.

In a discussion of dust, Mr. Park said that it was a great fire hazard as it either causes or spreads fires by a series of explosions. He said air containing .05 oz. of dust per cubic ft. of air is a minimum for an explosive condition and that .25 oz. per cubic ft. was a maximum for explosive force. He said that a dust layer less than 1/16 in. thick in a room, if suspended in the air is sufficient to be explosive; and that a dust layer ¼ in. thick would make or produce the maximum explosive violence.

He said that dust explosions usually start from localized "puff" clouds and that pressure waves stir up additional dust which in turn explodes, and, like a chain reaction, soon reaches maximum explosiveness.

Dust on the floors and on beams or ledges is the principal fuel for an explosion and he said that the only solution was a continuous removal of any accumulated dust.

Controlling dust is the most difficult technical engineering problem in feed and flour mill design, he said. A dust collecting system must be rechecked, he said, when any change or addition is made to the system to be sure that it will do the job correctly. All-metal cyclones, he said, were the most inexpensive and free of fire hazards.

He recommended that the firm's insurance company should be consulted regarding any change in the dust handling system that might be made in a feed or flour mill.

The safety engineer said that the only excuse for using a belt dressing is to keep the leather in condition and that, by no means, should belt dressing be used as an adhesive to make a belt pull a load. He said that if belt dressing is required, it indicates that the drive is not designed properly.

Mr. Park said that the incidence of fires originating from grain dryers is steadily declining, due to improved engineering of them, and he said that the majority of grain dryer manufacturers are now designing equipment that meets underwriters' specifications satisfactoriiy.

He recommended the automatic discharge of employees found guilty of violating a plant's "No Smoking" rule. It was his opinion that smoking in restricted areas probably is responsible for more fires than are actually reported.

Proper fire protection of a feed plant is very important, Mr. Park said, and he recommended that all

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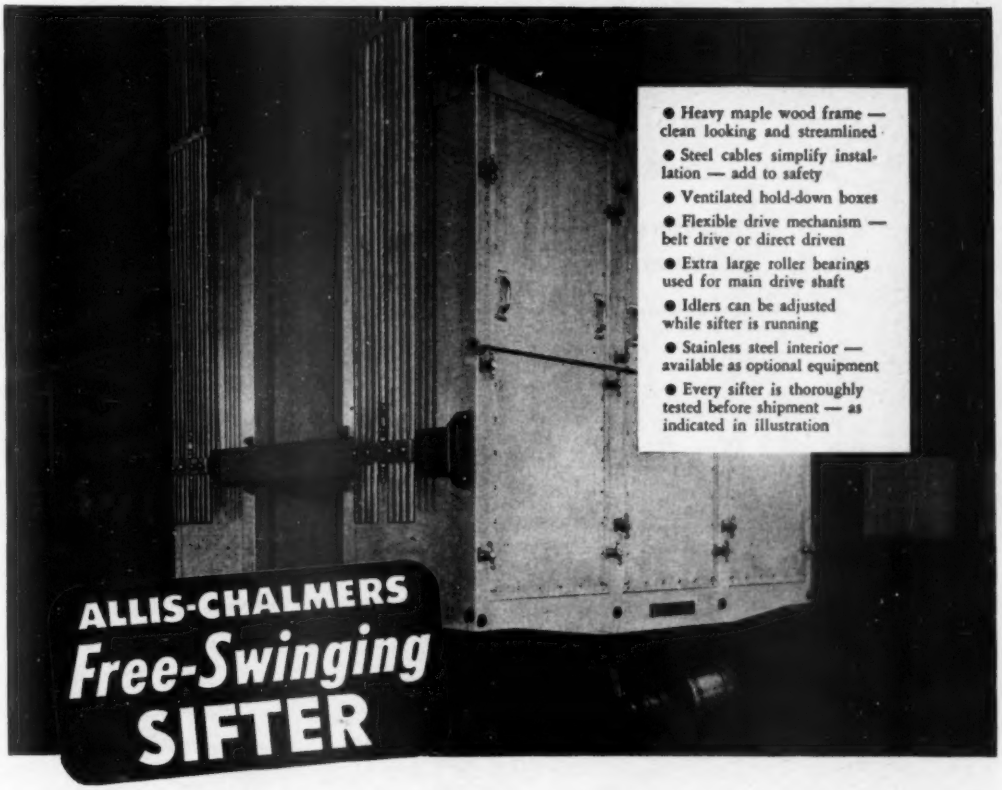
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employees should be instructed in the use of fire fighting equipment.

Mr. Park said that there were three general classes of fire extinguishers: Class A is designed for use against freely burning organic substances such as wood and paper. Class B is designed for inflammable liquids such as gasoline and Class C extinguishers, using carbon tetrachloride or carbon dioxide, were designed for use against fires in electrical equipment.

There must be cooperation between the plant personnel and the local fire department for efficient fire control, Mr. Park said. He recommended that the chief of the fire department or battalion should be made familiar with the layout and processes in the plant.

He made these recommendations regarding cooperation with the fire department: First, one man on each shift should be held responsible for turning in all fire alarms. He said that all too many times in the excitement it might be assumed that "the other fellow" has notified the fire department, and there have been instances, he said, when the fire department was not notified. His second recommendation was that a man should be stationed at the entrance to the plant grounds to meet the department equipment and direct it to the fire. His third recommendation was that immediately upon discovery of a fire the department be notified and then the plant personnel should attempt to control or confine the fire while the fire department equipment is on its way. In too many instances the fire department is not notified of the fire until it has gotten beyond control and by the time it arrives the fire is even beyond the control of the department.

Feed Packing Machines Described for Millers

Pictures of several new feed packing machines now undergoing tests in the Kansas City plant of General Mills, Inc., were shown by J. W. Speers, superintendent in charge of packing and loading for the GMI plant. Mr. Speers prefaced his discussion with comments about the variety of packages and products now being produced by formula feed plants.

He showed projection pictures of Model EE 39 Richardson Automatic Packer which, he said, was performing very satisfactorily on mash feeds but was not suitable for molasses feed. He said the Richardson company is producing its Model GGG 38 specifically for handling molasses feeds and said that this machine must be cleaned with steam daily to insure accurate operation. **Vibrox** agitators are used in conjunction with the charging bins over this packer.

Mr. Speers also showed pictures of two machines produced by the St. Regis Sales Corp. Its Model 100 PB is designed for packing 50- or 100-lb. packages and is a three-tube machine for use with valve bags. He said that when mashes were being packed, the three-tube machine could pack from 15 to 18 50-lb. bags a minute.

Another St. Regis machine—the Model 152 PB—was also pictured. This machine is used to pack pellets in 50-lb. paper bags. It is a two-tube machine.

The presentation consisted of the showing of about 25 projection slides and a short description of each picture by Mr. Speers. He invited feed mill superintendents to come to the General Mills plant at any time to see how different feed products were packed and handled.

* *

Handling Molasses in Feed Plants

The "do's and don't's" of molasses handling were given by John Czarev superintendent for the Schreiber Mills, Inc., St. Joseph, Mo. Mr. Czarev explained that most cars for shipping molasses contain heating coils and that the tank car should be heated to reduce the viscosity of the molasses so it will flow easily either into the bulk pit underneath the car or into the pump line.

Mr. Czarev said that a number of small tanks are better for storing molasses than a single large tank. He said that the smaller tanks could be cleaned easier and that it afforded easier handling of bulk molasses. Molasses tanks, he said, should never be filled to capacity. He recommended allowing sufficient space between the top of the molasses and the tank to allow for expansion of the molasses. He said also that the tanks should be well ventilated.

Rotary gear pumps were recommended by Mr. Czarev as being the most satisfactory for handling of molasses. He recommended the use of control devices that would prevent the overflowing of molasses tanks and one superintendent in the audience volunteered the information that he had used a Bin-Dicator for that purpose. Mr. Czarev also said that if molasses was being fed into a bulk mixer or collector line by gravity, maintaining of an even level in the molasses tank is quite important. He said that there should be always a uniform head of molasses over the outlet to insure that the right amount of molasses was flowing into the feed at all times.

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